
ENVIRONMENTAL Fact Sheet



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WD-DWGB-4-1

2008

Interpreting the Presence of Coliform Bacteria in Drinking Water

Determining the bacterial quality of drinking water is the single most important water quality test. Why? Because one glass of water containing just a few disease organisms can cause illness. When minimal exposure creates an immediate health risk, that contaminant is known as an acute contaminant. Bacterial contaminants of *E. coli* and fecal coliform in drinking water represent an acute health risk. In contrast, meaningful health risk from most chemical contaminants, such as arsenic, radon, or benzene, requires a long period of exposure, typically over many years. These factors would be described as chronic.

The total coliform test is the basic yardstick for determining the biological quality of drinking water. This test is performed frequently because of the risk that disease-causing organisms pose to the users of that water supply. The test is easy to perform, inexpensive, and errs on the side of caution.

Total Coliform as an Indicator Organism

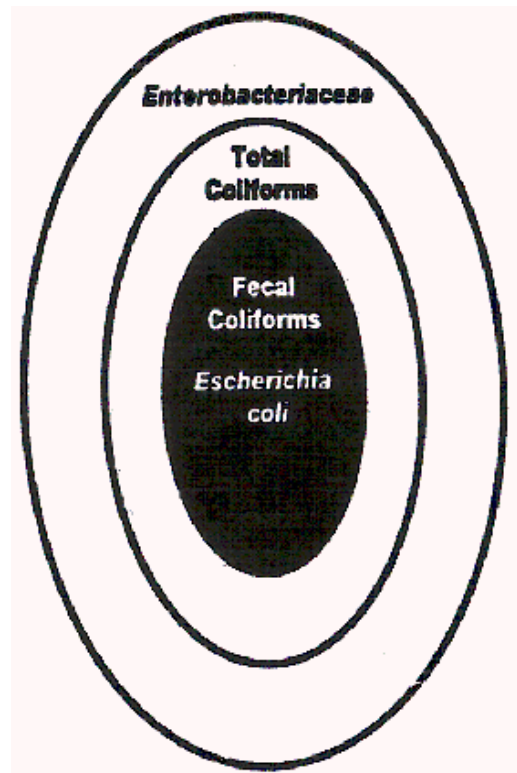
The organisms in the total coliform group are called indicator organisms. That is, their presence indicates the possibility, but not the certainty, that disease organisms may also be present in the water. When total coliforms are absent there is a very low probability of disease organisms being present in the water. The ability of the total coliform test to reliably predict the bacterial safety of drinking water relative to the hundreds of possible diseases is critical since it is impossible, in a practical sense, to check frequently for every disease type.

Recently however, public health experts have recognized that certain protozoa that cause disease, such as *Giardia* and *Cryptosporidium*, can be present in water even when the total coliform test shows an absence of organisms. Under such circumstances illness could occur. Although this is an important exception, the total coliform test remains the standard for determining the bacterial quality of drinking water in the U.S. and the world.

Risk Associated with Coliform Types

There are a number of subgroups within the overall coliform family as shown in the diagram. The presence of bacteria from each progressively smaller subgroup heightens the concern that disease-causing organisms may also be present in the water. These groups and their relative risk implications are discussed below.

Total Coliform. These organisms are very prolific in the soil and their presence does not necessarily imply poor wastewater disposal or the presence of other sanitation based health risks. The presence of only total coliform generally does not imply an imminent health risk but does require an analysis of all water system facilities and their operation to determine how these organisms entered the water system. Public notice to water system users is required since a properly constructed and properly maintained water system should not have total coliform present. When only total coliform are present, the water system is allowed 30 days to give public notice to customers that the water has violated a drinking water standard. This lengthy period indicates the industry's perception of a low degree of immediacy to the risk.



Fecal Coliform. This is a specific subset within the total coliform family. Fecal coliform generally originate in the intestines of mammals. They have a relatively short life span compared to more general coliforms. Their presence could be related to improper disposal of sanitary waste. Immediate public notice and a boil order to the users (within 24 hours) are required due to the higher perceived risk of disease organisms also being present in water.

***Escherichia coli* (E. coli).** This is a specific species (subgroup) within the fecal coliform family. *E. coli* originate only in the intestines of animals including humans. Like fecal coliform, they have a relatively short life span compared to more general coliform. Their presence indicates a strong likelihood that human or animal wastes are entering the water system. Immediate public notice and a boil order (within 24 hours) are required due to a higher perceived risk of disease organisms also being present in the water.

Non-Coliform Bacterial Results

Many bacterial identification procedures can be used to determine the presence of coliforms. One test, the membrane filter test, produces a test result for non-coliform organisms in the water. In some cases there is a substantial presence of non-coliform bacteria. Excessive non-coliform results provide two important areas of information upon which to base an evaluation of water safety.

Invalidation of the Total Coliform Test

When the number of non-coliform organisms is high, their presence may inhibit the growth of other more important organisms in the total coliform family. Where present in numbers over 200 colony forming units (CFUs) in a 100 milliliter sample, the excessive non-coliforms will invalidate that total coliform test.

Non-coliform as an Indicator of Inadequate Filtration

There should be a small number of non-coliform organisms in a properly constructed well. Thus when non-coliforms are numerous in groundwater samples, there is concern that the water in the well is not being adequately filtered. Reasons for a lack of adequate filtration include: the well is not properly constructed; or the soil/rock layering is not properly filtering the rainfall or runoff that is percolating down from above to the well.

Conflicting Coliform Data

Sometimes bacterial tests from the same PWS, under the same conditions, are not consistent.

Samples Taken at Different Times

In this situation, tests at different times produce different results. This is easier to evaluate. In a well where water is not adequately filtered, bacteria are expected to be present. Organisms that gain access to a well can be there one day and die off before a second sample is taken a few days or a week later.

Samples Taken at the Same Time

In this situation, different bacterial samples taken at the same time and place, give different results. This is a somewhat unlikely but possible event. One simple explanation is the diversity of coliform test methods. Some bacterial tests use a filtration step while others do not. Each uses a different proprietary media to incubate the organisms. The counting of bacteria in some cases is of organisms while in other cases we are measuring enzyme byproducts of the life cycle of these organisms. Some methods will better detect coliform species that have been stressed by chlorine or other harsh environmental conditions while others will not. Finally, fully representative samples are hard to obtain since bacteria often congregate together in clumps in pipes and in the sample container. Thus, in cases where there are few organisms, they may not be evenly distributed in the water.

Laboratory Methods of Total Coliform Identification

All methods of total coliform identification require culturing of the sample in the presence of a special food source. The culturing process requires approximately one to two days of culture growth before interpreting the bacterial data. There are three laboratory procedures that can be used for determining the presence of total coliform in a water sample. Their names and the constraints of each are summarized below:

Multiple Tubes. This method was developed in the early 1900s. It uses a number of test tubes and measures the amount of gas production during incubation. Results are stated using the term most probable number of organisms (MPN) per 100 milliliters of samples, taking two days for incubation. Advantages include being the first reliable bacterial method for drinking water; disadvantages include significant glassware use and

required laboratory cleanup.

Membrane Filter. This method was developed in early 1950s. It filters organisms from the water onto a paper surface and then incubates the initial parent organisms to produce colonies that can be seen. Resultant growths are counted by the laboratory staff. A minimum of 22 hours incubation time is required. Results are identified as “counts” of CFUs per 100 milliliters. The advantage of this method is that it’s much simpler than test tubes; the disadvantage is that it can’t be used on muddy water.

MMO Chromogenic Fluorogenic Method. This method was developed in the late 1980s. The method consists of culturing the organisms in the actual sample bottle. A yellow color indicates the presence of total coliform, and the presence of a fluorescent condition under black light indicates *E. coli*. Incubation time of 18-28 hours is required. Results are stated as the presence or absence of coliform organisms per 100 milliliters. Non-coliform organisms are not produced.

FOR MORE INFORMATION

Please contact the Drinking Water and Groundwater Bureau and the New Hampshire Water Well Board at (603) 271-2513 or dwgbinfo@des.nh.gov or visit our website at www.des.nh.gov/-organization/divisions/water/dwgb/index.htm. All of the bureau’s fact sheets are on-line at www.des.nh.gov/organization/commissioner/pip/factsheets/dwgb/index.htm.

Note: This fact sheet is accurate as of September 2008. Statutory or regulatory changes or the availability of additional information after this date may render this information inaccurate or incomplete.